

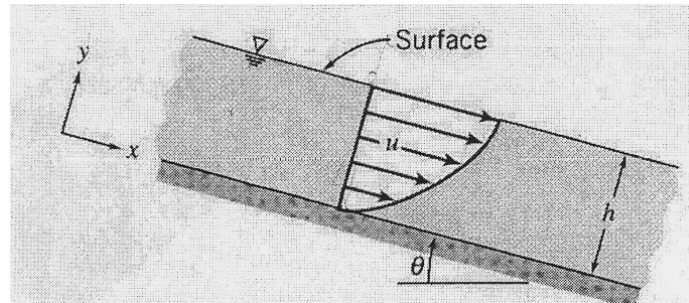
HW#7 SP07

#1.

Oil flows steadily in a thin layer down an inclined plane. The velocity profile is

$$u = \frac{\rho g \sin \theta}{\mu} \left[hy - \frac{y^2}{2} \right].$$
 Express the mass flow rate per unit width in terms of ρ , μ , g ,

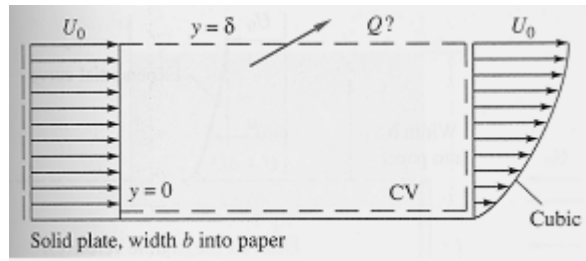
θ and h .



#2.

An incompressible fluid flows past an impermeable flat plate as in the figure, with a uniform inlet profile $u = U_0$ and a cubic polynomial exit profile $u \approx U_0 \left(\frac{3\eta - \eta^3}{2} \right)$

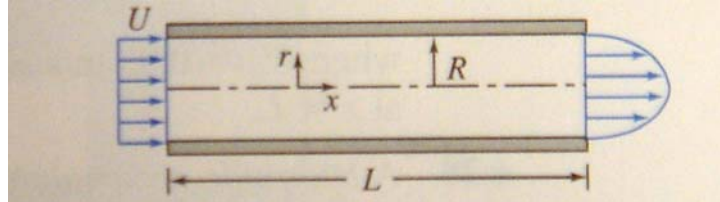
where $\eta = \frac{y}{\delta}$. Compute the volume flow Q across the top surface of the control volume.



#3.

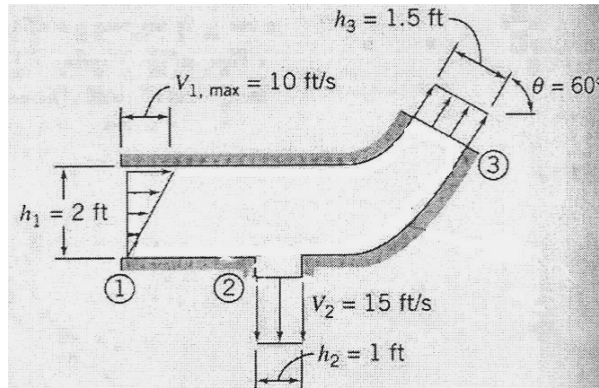
Water flows steadily through a pipe of length L and radius $R = 3 \text{ in.}$ Calculate the uniform inlet velocity, U , if the velocity distribution across the outlet is given by

$$u = u_{\max} \left(1 - \frac{r^2}{R^2}\right) \text{ and } u_{\max} = 10 \text{ ft/s.}$$



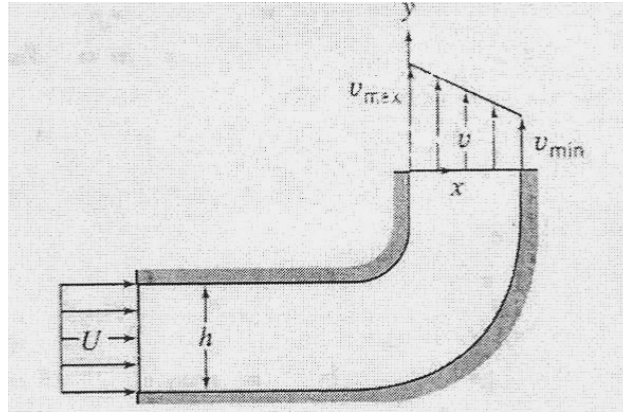
#4.

A two-dimensional reducing bend has a linear velocity profile at section ①. The flow is uniform at sections ② and ③. The fluid is incompressible and the flow is steady. Find the magnitude and direction of the uniform velocity at section ③.



#5.

Water enters a two-dimensional square channel of constant width, $h = 75.5$ mm, with uniform velocity, U . The channel makes a 90° bend that distorts the flow to produce the linear velocity profile shown at the exit, with $v_{max} = 2 v_{min}$. Evaluate v_{min} , if $U = 7.5$ m/s



#6.

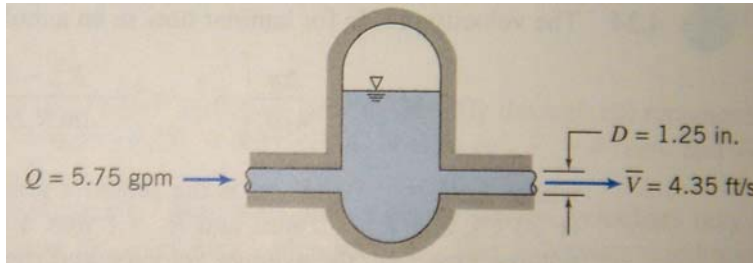
A laboratory test tank contains sea water of salinity S and density ρ . Water enters the tank at conditions (S_1, ρ_1, A_1, V_1) and is assumed to mix immediately in the tank. Tank water leaves through an outlet A_2 at velocity V_2 . If salt is a “conservative” property (neither created nor destroyed), use the Reynolds Transport Theorem to find an expression for the rate of change of salt mass M_{salt} within the tank.

#7.

A room contains dust of uniform concentration $C = \rho_{\text{dust}}/\rho$. It is to be cleaned up by introducing fresh air at velocity V_i through a duct of area A_i on one wall and exhausting the room air at velocity V_o through a duct A_o on the opposite wall. Find an expression (using Reynolds Transport Th.) for the instantaneous rate of change of dust mass within the room.

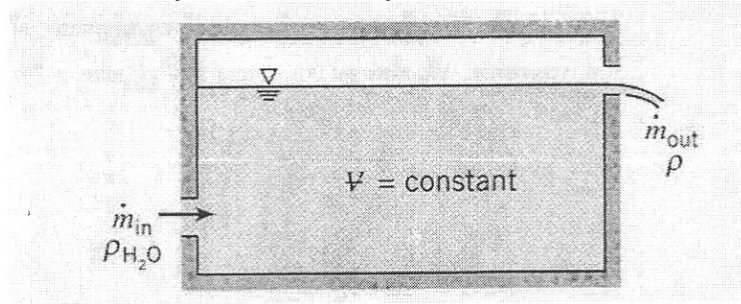
#8.

A hydraulic accumulator is designed to reduce pressure pulsations in a machine tool hydraulic system. For the instant shown, determine the rate at which the accumulator gains or loses hydraulic oil.



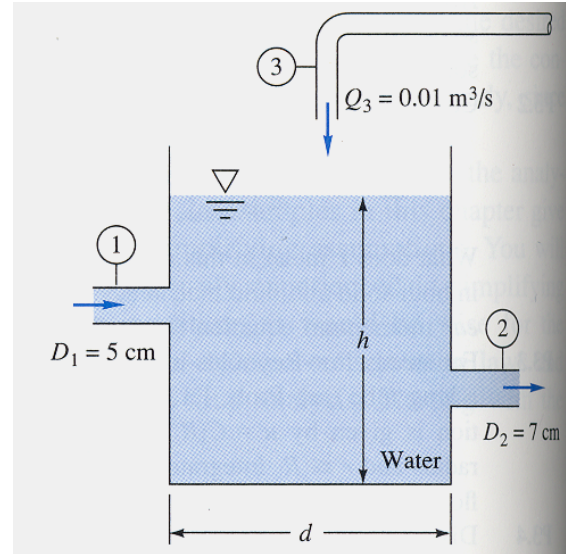
#9.

Tank of fixed volume contains brine with initial density, ρ_i , greater than water. Pure water enters the tank steadily and mixes thoroughly with the brine in the tank. The liquid level in the tank remains constant. Derive expressions for (a) the rate of change of density of the liquid mixture in the tank and (b) the time required for the density to reach the value ρ_f , where $\rho_i > \rho_f > \rho_{H_2O}$. Use Reynolds Transport Th.



#10.

The open tank in the figure contains water at 20°C and is being filled through section 1. Assume incompressible flow. First derive an analytic expression for the water-level change dh/dt in terms of arbitrary volume flows (Q_1 , Q_2 , Q_3) and tank diameter d . Then, if the water level h is constant, determine the exit velocity V_2 for the given data $V_1 = 3 \text{ m/s}$ and $Q_3 = 0.01 \text{ m}^3/\text{s}$.



#11.

Water flows steadily past a porous flat plate. Constant suction is applied along the porous section. The velocity profile at section cd is $\frac{u}{U_\infty} = 3\left[\frac{y}{\delta}\right] - 2\left[\frac{y}{\delta}\right]^{1.5}$. Evaluate the mass flow rate across section bc .

